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ABSTRACT

A study was conducted to examine learning from textbook sentences that provide examples. It was predicted that an example written succinctly and with a word order that emphasized its parallel semantic relations with the exemplified principle, such as "animals have parasites; dogs have fleas," would have a positive effect on idea comprehension. It was also predicted that examples with many irrelevant details or examples without explicitly stated principles would have neutral or negative effects on idea comprehension. Three versions of a 10th grade biology textbook chapter were constructed: well constructed examples (E+), poorly constructed examples with mostly unimportant principles illustrated (E-), and conditions with no example (NO). Ninety-two university undergraduate students read one of these three versions and performed a free recall task. As predicted, the recall performance was higher in the facilitative example (E+) condition than in either of the other two conditions. There was no difference in overall recall between the (E-) and the (NO) conditions. The protocols were also examined to see if, when the examples were recalled, their principles were recalled also. Subjects in the (E+) condition recalled the examples' principles 95% of the time, while subjects in the (E-) condition recalled only 59% of the corresponding principles. (HTH)

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THE EFFECTS OF EXAMPLES ON THE COMPREHENSION OF TEXTBOOKS

by

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Mandler and Johnson (1977) have shown that even young children know the typical structure of stories and use this knowledge to comprehend the stories that they read. However, there is some question whether students have effective schemas for structuring the expository information found in textbooks. For example, do students understand the function of examples as clarifiers of principles? There is evidence that many students do not have the cognitive skills to learn successfully from textbooks, although such readers often read narrative material quite well (Estes and Vaughn, 1978). Typically information in narrative is organized differently than information in expository text (Deese, 1981). Thus, one reason that readers find narrative text less difficult may be that they have better schemas for interpreting the informational structure in stories.

Studying the ability of students to learn from textbooks, the Scientific Textbook Reading Project has been conducted at the University of Virginia since 1979 by James Deese, Thomas Estes, John Rotondo, Wayne Shebilske and M. Elizabeth Wetmore. This project's general approach has been to assign a chapter of textbook reading to students at several grade levels and then test the students' comprehension of the chapter. Initial results indicate that many students do not use effective organizing schemas for understanding textbooks; that is, they tend to recall many minor ideas but forget many of the more important ideas (Shebilske and Rotondo, 1981; Estes, 1980). Furthermore, these comprehension difficulties

seemed to be correlated with text characteristics. Specifically, the college text under examination was written in a deductive style with important principles stated at the beginning and followed by less important elaborations. The tenth grade text, however, was written in an inductive style with minor ideas and examples leading up to important ideas. College readers had more difficulty comprehending the inductively written text even though it was written for a lower grade level. Thus, the presentation of general principles at the beginning of the deductive style text may have been more compatible with the college readers' schema for textbooks.

Other findings from the Reading Project which relate more directly to the current topic of the effects of examples on text comprehension have indicated that many students do not use examples effectively. For instance, in many cases subjects could recall an example but not the principle that the example was there to illustrate (Shebilske and Rotondo, 1981). As with comprehension in general, the students' difficulties appeared to be related to the writing styles of the texts. In some cases, examples seemed to contain an excess of vivid details that may have distracted readers from the examples' illustrative function. There were also indications that exemplifying unimportant ideas inhibited the learning of important ideas.

After examining the materials used in the Reading Project and in other textbooks, I developed an inventory of the styles used in writing examples. Three of these styles will be discussed before preceding to

the specifics of the study. Figure 1 presents samples (not used in the current study) of these three styles. The first sample shows what I term the "prototypic" type of example in which the example succinctly and straightforwardly illustrates a principle. It is argued here that text examples contain concepts that have parallel semantic roles to concepts in the corresponding principle. These parallels are indicated in the samples by underlining and letter labels, e. g. the parallel concepts (a) mules and (A) offspring. Following the model of Kintsch and Van Dijk (1979), it is proposed that the principle is encoded and stored in a short term memory buffer where it will later be interrelated with the example. If the semantic parallels with the example are perceived, this additional processing of the principle should aid its memorability. The prototypic type of example would appear to be an effective form of example since the word order emphasizes the semantic parallels with the principle, and there is a minimum of concepts beyond that needed to illustrate the point. Besides such direct facilitation of idea comprehension, examples may indirectly affect the comprehension of ideas that are not exemplified. For instance, if the comprehension of a topic sentence is directly aided by an example, the comprehension of ideas subsumed under the topic sentence should also be affected, since understanding those ideas depends on an understanding of the topic sentence.

In the next sample of text in Figure 1, there is a type of example that contains what is termed "excessive detail." Added to the core of the

FIGURE 1

TYPES OF EXEMPLIFICATION

Prototypical Type of Example

There are many ways to maintain species separation.
The (A) offspring of (B) two different species are sometimes completely (C) sterile.
For example, (a) mules, which are a cross between (b) horses and donkeys are almost always (c) sterile.

Excess Detail in Example

There are many ways to maintain species separation.
The offspring of two different species are sometimes completely sterile.
For example, mules, which are a cross between horses and donkeys, are almost always sterile.
The fact that mules can be stubborn and that sometimes people kick them to make them move may be another effect of the crossbreeding.

Principle Not Stated Explicitly

There are many ways to maintain species separation.
For example, mules, which are a cross between horses and donkeys are almost always sterile.

prototypic type of example are other details which presumably "lighten" the material, but contribute little to the clarification of the principle. It is predicted that such details will usually inhibit the interrelating of the example and principle. That is, excess details may overload the memory buffer and "bump out" other ideas, thus reducing the memory strength of the ideas.

In the third text sample, only the example is stated explicitly, requiring the reader to induce the principle. This example type may also lead to poor comprehension of the principle since readers are less likely to encode a principle that is not written out for them. Although there are many other styles of exemplification, e.g. examples which precede the principle, or which illustrate several ideas, they are the topic of future research and will not be covered here.

Besides the issues of how to state principles and examples, the rationale for deciding which principles should be exemplified needs to be studied. As a working heuristic, it is proposed that important, rather than unimportant, ideas should be exemplified to help guide readers' allocation of cognitive resources.

In summary, it is proposed that the prototypic type of example should facilitate the comprehension and recall of principles and that mostly important principles should be exemplified. In contrast, examples with an excess of details or where the principle is not stated explicitly should have neutral or negative effects on comprehension.

Since there is little prior research on the use of written textbook examples, I began with a strong manipulation by comparing reading comprehension for a passage with well constructed (prototypic) and well placed examples to that for a passage with a poor use of examples.

METHOD

Subjects

Ninety-two University of Virginia undergraduates took part in this experiment. All of the subjects were students in an Introductory Psychology course; taking part in the experiment was one way to fulfill a course requirement.

Design

A one factor, three group between-subjects ANOVA design was used, with the factor roughly corresponding to the quality of the use of examples. Subjects in each group read one of three versions of a tenth grade biology textbook chapter: (1) No Example (NO) version, containing no examples; (2) Facilitative Example (E+) version, containing examples that were predicted to facilatate the learning of principles and facts and in which mostly important principles were exemplified; and (3) Inhibitory Example (E-) version containing examples predicted to have a neutral or negative effect on learning and in which mostly unimportant ideas were exemplified. The amount of information learned from the chapter was tested by a Free Recall task.

Procedure

The subjects were run in groups of 10 to 30, and each subject was randomly assigned to one of the three conditions. They were given both verbal and written reading, and Free Recall instruction. Major points of the reading instructions were that (1) readers should read every sentence and not skim sentences and (2) they could underline or take marginal notes as they wished. For Free Recall subjects were asked to write down all they could remember from the passage in complete sentences if possible, and to use their own words, if necessary. Subjects performed the reading and Free Recall tasks at their own pace.

Materials

Three passages were constructed based on a tenth grade biology textbook chapter on the topic of speciation and classification (Haynes, 1973) that had been used in the University of Virginia Reading Project. The major reasons for selecting the source chapter were that the textbook had been widely used in high schools and that the examples used fit into the Inhibitory Example types as defined here. Thus, for the most part, original textbook examples were used in the E- passage rather newly constructed ones. Also, Reading Project researchers had gathered importance ratings of the text ideas. A group of University of Virginia undergraduates (not participants in the current study), rated the importance of the text ideas in relation to the overall chapter topic using a ten point scale (Shebilske and Rotondo, 1981).

All three passages retained the chapter title, section titles and paragraphing of the original chapter, but no photographs or non-verbal illustrations were included. To construct the E- passage, examples from the original chapter were usually retained if they had excessive details and/or the corresponding principle was not stated. In addition, four examples were dropped, and three new examples were constructed to ensure that a major proportion (58%) of the exemplified ideas were unimportant. The E+ passage was constructed using the following working rules. (1) Examples of important principles in the original chapter were rewritten to fit the prototypic type. (2) New prototypic examples were written for previously unexemplified, important ideas. (3) Principles that were unstated in the original (and E-) passages were stated in the E+ passage. In the E+ passage, 30 of the 66 chapter ideas were exemplified and the average importance of the exemplified ideas was 7.3. In contrast, 24 of the 66 ideas were exemplified in the E-passage, and the 24 ideas had an average importance of 4.1 The NO passage was constructed by simply eliminating all examples from the E+ passage, leaving just the 66 principles and facts. The passage lengths were 1950, 2624 and 2806 for the NO, E+ and E- passages respectively, with corresponding average reading rates of 135, 137 and 143 words per minute.

Samples of the passages and the construction process are shown in Figure 2 for two ideas. Idea # 51 (geographical separation can prevent interbreeding) was not stated explicitly in the source chapter or the E- passage and the corresponding example contained an excess of details.

FIGURE 2

SAMPLE IDEAS AND EXAMPLES FOR EACH PASSAGE

Idea 51

E- Passage Idea 51

Alaska brown bears and polar bears provide a somewhat different example. In the Washington Zoo these species have successfully mated and produced vigorous, fertile offspring. However, in the wild no such cross has ever been discovered. The reason? Brown bears live in forests, eating berries, small animals and fish that they catch in streams. Polar bears live on snowfields and ice floes, catching seals for food. Thus brown bears and polar bears rarely, if ever, see each other--except in zoos.

NO and E+ Passages Idea 51

NO Another reason that some animals may not breed in the wild is that they live in entirely different geographical regions.

E+ For example, brown bears and polar bears can mate in zoos but in the wild they live in entirely different areas, and never get the chance to interbreed.

Idea 28

E+
NO We might decide to look for likenesses in color.

E- So we lump together organisms that are blue: bluebirds, bluegrass, bluefish, blue crabs, blue spruce.

The principle is stated in the E+ and NO passages and the E+ version contains a prototypic example, without excess details. Idea #28 was an unimportant idea, so the original example was left out of the E+ passage but included in the E- passage.

Results

Table 1 shows the number of passage ideas recalled, averaged over subjects for all three passages, based on scoring the protocols for gist recall. As predicted, the recall performance was higher in the Facilitative Example (E+) condition than either the Inhibitory Example (E-) or No Example (NO) conditions ($p < .005$). But there was no difference in the overall recall between the E- and NO conditions. Since the results of Table 1 are for all the passage ideas, the results cannot show whether using examples affected just the ideas that were exemplified or other ideas also. Table 2 shows the recall performance for the exemplified ideas (direct effects of examples) and those not exemplified (indirect effects) for the E+ condition. It is clear that all the facilitative effects were direct effects in the E+ condition. A similar analysis, comparing recall in the E- and NO conditions (Table 3), shows no significant direct or indirect effects from E- passage examples, although there was some tendency for E- examples to indirectly inhibit idea recall ($p < .15$).

To get an additional indication of whether subjects were able to use examples effectively, the protocols were examined to see whether when examples were recalled their principles were recalled also.

TABLE 1

Overall Free Recall

66 Total Ideas

Passage Version	Number of Subjects	Average Number of Ideas Recalled
NO	30	12.9
E+	30	17.0*
E-	32	11.9

* $P < .005$ compared to NO and E- conditions

TABLE 2

Direct/Indirect Effects - Facilitative Condition

	Number of Ideas	Proportion of Ideas Recalled	
		NO	E+
Exemplified Ideas (Direct Effects)	30	.25	.38*
Ideas Not Exemplified (Indirect Effects)	36	.15	.16
	66		

* $p < .05$ vs. NO condition

TABLE 3

Direct/Indirect Effects - Inhibitory Condition

	Number of Ideas	Proportion of Ideas Recalled	
		NO	E-
Exemplified Ideas (Direct Effects)	24	.28	.29
Ideas Not exemplified (Indirect Effects)	42	.14	.11
	66		

Subjects in the E+ condition produced 133 examples for an average of 4.4 per subject (SD=2.1). Given that an example was recalled, subjects also recalled the example's principle 95% of the time. On the other hand, subjects in the E- condition produced 106 examples, 3.3 per subject (SD=1.7), and only recalled 59% of the corresponding principles.

In addition to analyzing the overall recall levels, the relative proportions of important (ratings 6 and above) and unimportant ideas were examined. A higher proportion of the 44 important ideas was recalled in E+ condition (.32) than in the E- condition (.22) or NO condition (.23), ($p < .001$). In contrast, the recall of unimportant ideas was the same for all three conditions.

Discussion

The results in Table 1 support the prediction that the prototypic type examples of the E+ passage would facilitate the learning of text-book ideas. Also as predicted, the E- passage examples did not aid idea recall. The major differences between the examples in the two passages were that the E- examples contained details that were superfluous for clarifying the principles and that in the E- passage the principles were not always stated separately from the examples. Although these factors were partially confounded so that it is difficult to say which was more important, it is plausible that each factor reduced the effectiveness of exemplification in the E- passage. Reading excessive details may have strained cognitive resources such as a memory buffer (Kintsch and Van Dijk, 1979) or distracted readers from the information

in the example that was relevant for clarifying the principle. The distractive effect of excessive details may be analogous to the distraction sometimes caused by text illustrations or pictures. The negative effects of example details is consistent with the results of Reder and Anderson (1980), who showed that eliminating minor ideas from a textbook passage could improve the recall of important ideas. Leaving principles unstated could also cause comprehension and recall difficulties when readers fail to induce the principle from the example. The fact that subjects in the E- condition often recalled the examples, without indicating an understanding of the corresponding principles, supports the proposal that the E- examples were not interrelated well with the principles. Thus, it is important to state the example succinctly so that its relationship to the principle is as clear as possible, as was done in the E+ passage.

It was proposed that the E- examples might cause a decrease in idea recall relative to the NO passage, but there were no significant effects in the current study. There was a tendency in E- passage for the recall of non-exemplified ideas to be inhibited (Table 3). In a study with different materials, Twohig (1982) showed that examples with excessive details inhibited the recall of non-exemplified ideas (indirect effects), particularly the ideas that immediately followed the examples. Such indirect, inhibitive effects were weak in the current study most likely because the exemplified ideas tended to come one after the other and there were relatively few non-exemplified ideas adjacent to examples.

A major difference between the E+ and E- passages was that most of the exemplified ideas in the E+ passage had been rated as important to the overall chapter topic. This exemplification pattern increased the proportion of important ideas recalled without reducing the recall of the other ideas (Table 4). Thus, properly written examples, e. g. the prototypic style, can be used to guide readers' allocation of cognitive resources towards the most significant information. As Kintsch and Van Dijk (1979) have pointed out, readers knowledge about the organization of the text, e. g. science textbook, can effect the way they organize and interrelate information during reading. If readers assume that authors primarily exemplify what is important, there may be comprehension difficulties when these expectations are not met. On the other hand, if the examples are poorly written as with the E- passage here, some readers may not be able to use the examples effectively even when important ideas are exemplified.

In conclusion, a beginning has been made on working guidelines for constructing and placing written examples in textbooks and for identifying factors that make comprehension difficult. There are implications for counseling students who have trouble learning from textbooks. For example, how well do they relate principles to examples and do they get lost in example details? It is clear that more work is needed with a wider variety of materials. Future research will include the effects of placing examples before rather than after the principle and constructing examples that can interrelate several ideas.

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